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United States Department of the Interior
FISH AND WILDLIFE SERVICE

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Sacramento Fish and Wildlife Office
3310 El Camino Avenue, Suite 130
Sacramento, California 95821-6340

July 28, 1997

Mr. Lester S. Snow
Executive Director
CALFED Bay-Delta Program
1416 Ninth Street, Suite 1155
Sacramento, California 95814

Subject: San Francisco Estuary Institutes's Category III Exotic Species Control
Proposals

Dear Mr. Snow:

The Sacramento Fish and Wildlife Service Office supports the eight proposals submitted by the San Francisco Estuary Institute for exotic species research and control in the Sacramento-San Joaquin Bay-Delta estuary. These eight projects fit within the recommended actions in the Delta Native Fishes Recovery Plan and will help recover listed species in the estuary.

The Service recommends funding of these projects. Such projects are consistent with our mission of preserving fish and wildlife and recovering natural ecosystems and watersheds.

If you have any questions or concerns about the above, contact Robert Pine at (916) 979-2725.

Sincerely,

Patricia Leonard

Per Wayne S. White
Field Supervisor

CC: San Francisco Estuary Institute, Richmond, California

- a. Project Title:** Effects of Flood-year Disturbance on Species and Guild Structure of Invaded Communities

Applicant's Name: The San Francisco Estuary Institute

Principal Investigators: Dr. Andrew Cohen, SFEI; Dr. James T. Carlton, Williams College, and John W. Chapman, Oregon State University

- b. Project Description and Objectives:** The objective of this project is to answer four key questions regarding biological invasions in the Estuary:

- Does habitat disturbance caused by extreme environmental events increase the probability of successful introductions?
- How do invaded communities respond to changes in the flow regime?
- How do changes in flows affect the balance between nonindigenous and native organisms?
- How are trophic dynamics in the Estuary affected by shifts in dominance by exotic species or guilds of species?

- c. Approach/Tasks/Schedule.** This project will assess the impacts of extreme high river flows on the invertebrate fouling community in the Estuary, one of the Estuary's most heavily invaded species assemblages, and compare these effects with effects at adjacent shallow-water benthic stations and nearby DWR and/or RMP sampling stations. The current proposal is a new project, but would build upon several years of work in developing rapid assessment methods, and in building a team with the necessary expertise for studying the fouling community. It will take advantage of a baseline data set developed for this community from 1993-1996.

Baseline work in 1993-1996 established methods for Rapid Assessment (RA) of the dock fouling community. As applied to the Estuary, those methods involved assembling a team of taxonomic specialists from around the country to jointly collect, field identify and confirm in the laboratory a phylogenetically broad spectrum of organisms from 16 core stations and several supplemental stations from the Delta to the Bay. Extreme high river flows occurred in 1994-95 and 1995-96 and are projected for this coming winter. The project will sample this community in 1997-1998 and analyze changes over the period 1993-1998. The same team that did this initial work will be available, and some additional specialties will be added. Analyses of both fouling and benthic communities will assess patterns of distribution and abundance relative to spatial and temporal variations in salinity and examine changes in community composition and in the relative dominance by nonindigenous organisms relative to variation in winter/spring flow regimes; and for benthic data, will compare these results with an analysis of DWR and RMP benthic sampling data for nearby stations during the same period. Analysis of fouling communities will assess variation in distribution and abundance of small (short-lived) taxa and large (long-lived) taxa and consider potential interactions of these groups.

- d. Justification for Project Funding by CALFED.** The San Francisco Bay Estuary is recognized as the most invaded aquatic ecosystem in North America, with more than 200 introduced invertebrates, fish, plants, and microorganisms. The introduction of nonindigenous species has been identified as a critical factor affecting the health of the Bay/Delta Estuary by water agencies, environmental groups, the CCMP, BCDC, USFWS, CALFED and others. It is one of the seven non-flow factors targeted for research and management by Category III funding, and is one of the main stressors listed by the technical teams as appropriate for near-term funding and priorities. Nonindigenous species may in general affect and have affected all of the priority habitats listed in this RFP. Researchers have also demonstrated or suggested that nonindigenous species have caused significant negative impacts on several priority species (salmon, trout, Delta smelt, sturgeon).

This project examines the interaction between flow (and in particular, extreme high flow events) and the ability of nonindigenous species to become established. Studies of the heavily

invaded dock fouling community and shallow water benthos can contribute through Rapid Assessment methods can help elucidate variation in environmental parameters can contribute to the initial success of invasions, and can alter the ecosystem effects of invasions.

- e. **Budget Costs and Third Party Impacts.** This is a three-year project. \$104,316 is required in the first year, \$105,128 in the second year, and \$140,795 in the third year.

No third party impacts are anticipated.

- f. **Applicant Qualifications.** The San Francisco Estuary Institute (SFEI) is a 501(c)(3) non-profit research institute created in 1994. SFEI is charged with fostering scientific understanding of the Estuary, and with promoting the implementation of a comprehensive, coordinated *Regional Monitoring and Research Strategy* that addresses the physical, biological and chemical health of the Estuary. SFEI's Biological Invasions Program researches issues of scientific and policy interest related to the introduction of nonindigenous species into marine and freshwater ecosystems. The research program is directed toward five objectives: (1) assisting efforts to prevent future invasions through scientific and policy research on vectors and the control of vectors; (2) developing an effective regional monitoring program to identify new invasions and track the spread of nonindigenous species that are present in the region; (3) understanding how factors in the environment affect the success of invasions; (4) assessing the impacts of invasions; (5) prioritizing and assessing efforts to control nonindigenous species that are present in the region.

Co-Principal investigator, Dr. James T. Carlton is the Director of the Maritime Studies Program at Williams College-Mystic Seaport. He is an internationally-recognized expert on nonindigenous species, and has worked on the fauna of the San Francisco Estuary for over 30 years. He is co-editor of the Third Edition of Light's Manual, the key to the Intertidal Invertebrates of the Central California Coast, and is currently at work on the fourth edition.

Co-Principal investigator, Dr. John Chapman received his Ph.D. from the University of California at Santa Barbara. He is the author of several papers on nonindigenous estuarine species in San Francisco Bay Estuary and the northeast Pacific and the criteria for introduced aquatic invertebrates. Through his work on nonindigenous peracarids he has made major contributions to the scientific knowledge of biological invasions on the Pacific Coast.

Co-Principal Investigator, Dr. Andrew Cohen received an M. S. and Ph. D. in Energy and Resources from the University of California at Berkeley. He is co-author of the 1995 USFWS report on nonindigenous species in the San Francisco Estuary and of papers on other aspects of marine and aquatic invasions. He currently directs the San Francisco Estuary Institute's research program on biological invasions.

In addition to the principal investigators, a uniquely-qualified core team of taxonomists and a large group of assisting taxonomists has been assembled to work on this project.

- g. **Monitoring and Data Evaluation.** The draft report will be submitted to the contract manager and to regional biologists with appropriate expertise for external review and comment. In addition, any persons recommended by CALFED will be asked to review the report. An article based on the results of this study will also be prepared for submission to a peer-reviewed scientific journal.
- h. **Local Support/Coordination with other programs/Compatibility with CALFED objectives.** All habitats and species included as priorities in the Ecosystem Restoration Program Plan could be directly or indirectly affected by the establishment of new exotic species, and thus stand to benefit from this project. Work will be coordinated with benthic sampling conducted by the Department of Water Resources (DWR) and with SFEI's Regional Monitoring Program (RMP) for Trace Substances, which contains a benthic sampling element.

Effects of Flood-year Disturbance on Species and Guild Structure of Invaded Communities

Principal Investigator: Andrew Cohen
San Francisco Estuary Institute
1325 South 46th Street
Richmond, CA 94804
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email: acohen@sfei.org

Co-Principal Investigators: John W. Chapman, Oregon State University
James T. Carlton, Williams College

Organization Type: Nonprofit research institute
503(c)(3) nonprofit organization

Tax identification number: 94-2951373

Contact person: Andrew Cohen

Participants/Collaborators: Claudia Mills, University of Washington
Leslie Harris, L. A. Co. Museum of Natural History
interns:
Jeffrey Crooks, Scripps Institute of Oceanography
Anna Weinstein, San Francisco Estuary Institute
contributed assistance:
Terence Gosliner, California Academy of Science
John Holleman, Merritt College (retired)
Michael Kellogg, San Francisco Water Quality Lab
Welton Lee, California Academy of Science
Richard Moe, U. C. Berkeley/Jepson Herbarium
Arlene Navarett, San Francisco Water Quality Lab
Greg Ruiz, Smithsonian Environmental Research Ctr
Paul Silva, U. C. Berkeley/Jepson Herbarium
Doris Sloan, U. C. Berkeley
Luis Solarzano, Sam Francisco State University
Robert van Syoc, California Academy of Science
Kerstin Wasson, U. C. Santa Cruz

Project Group Type: Services

Introduction: Biological Invasions in the Estuary

The San Francisco Bay Estuary is recognized as the most invaded aquatic ecosystem in North America, with more than 200 introduced invertebrates, fish, plants, and microorganisms. The introduction of nonindigenous species has been identified as a critical factor affecting the health of the Bay/Delta Estuary by water agencies, environmental groups, the CCMP, BCDC, USFWS, CALFED and others. It is one of the seven non-flow factors targeted for research and management by Category III funding, and is one of the main stressors listed by the technical teams as appropriate for near-term funding and priorities. Nonindigenous species may in general affect and have affected all of the priority habitats listed in this RFP. Researchers have also demonstrated or suggested that nonindigenous species have caused significant negative impacts on several priority species (salmon, trout, Delta smelt, sturgeon).

The San Francisco Estuary Institute has initiated a research program to address issues of scientific and policy interest related to the introduction of nonindigenous species into marine and freshwater ecosystems. The research program is directed toward five objectives: (1) assisting efforts to prevent future invasions through scientific and policy research on vectors and the control of vectors; (2) developing an effective regional monitoring program to identify new invasions and track the spread of nonindigenous species that are present in the region; (3) understanding how factors in the environment affect the success of invasions; (4) assessing the impacts of invasions; (5) prioritizing and assessing efforts to control nonindigenous species that are present in the region. Proposals in several of these areas are being submitted in the current funding cycle.

Project Description and Approach

Three key questions regarding biological invasions in the Estuary are:

- Does habitat disturbance caused by extreme environmental events increase the probability of successful introductions?
- How do invaded communities respond to changes in the flow regime?
- How do changes in flows affect the balance between nonindigenous and native organisms?
- How are trophic dynamics in the Estuary affected by shifts in dominance by exotic species or guilds of species?

Baseline work in 1993-1996 established methods for Rapid Assessment (RA) of the dock fouling community, one of the most heavily invaded communities in the Estuary. As applied to the Estuary, those methods involved assembling a team of taxonomic specialists from around the country to jointly collect, field identify and confirm in the laboratory a phylogenetically broad spectrum of organisms from 16 core stations and several supplemental stations from the Delta to the Bay. This work demonstrated that strong spatial distribution patterns within this community relative to salinity gradients were discernable by RA sampling methods. Data from this work indicated that the community exhibits dramatic fluctuations in

populations, community structure and trophic guild structure in response to extremely wet winters. These methods were also able to detect and identify several nonindigenous organisms, that were previously unknown in the Estuary.

This project will assess the impacts of extreme high river flows on the invertebrate fouling community in the Estuary, one of the Estuary's most heavily invaded species assemblages, and compare these effects with effects at adjacent shallow-water benthic stations and nearby IEP or RMP benthic sampling stations. Extreme high river flows occurred in 1994-95 and 1995-96 and are projected for this coming winter. Initial sampling of this community in 1993-1995 indicates that it exhibited major, sudden changes in species composition and biomass in the spring of 1995, apparently as a consequence of extreme high river inflows which constitute a major disturbance for this system. The project will sample this community in 1997-1998 and analyze changes over the period 1993-1998. Benthic samples will also be taken at these sites. Analyses of both fouling and benthic communities will assess patterns of distribution and abundance relative to spatial and temporal variations in salinity and examine changes in community composition and in the relative dominance by nonindigenous organisms relative to variation in winter/spring flow regimes; and for benthic data, will compare these results with an analysis of IEP and RMP benthic sampling data for nearby stations during the same period. Analysis of fouling communities will assess variation in distribution and abundance of small (short-lived) taxa and large (long-lived) taxa and consider potential interactions of these groups.

Objectives

Our specific objectives are to:

- Assess how severe flood seasons affect the proliferation and distribution of species and guilds of nonindigenous species.
- Assess how severe flood seasons affect the balance between nonindigenous and native species.
- Gather evidence on whether new nonindigenous organisms more often appear in the Estuary after high flood disturbance than in years without high flood disturbance
- Assess whether RA sampling methods can detect spatial patterns and track changes in invaded benthic communities.

Rapid Assessment Methodology

The RA methodology developed in 1993-96 is based on:

- 1) brief, expert, team investigations of sampling sites,
- 2) initial identification of living material in the field,
- 3) examination and workup of material in the laboratory shortly (within <1 to 3 days) after collection, and
- 4) supplemental, specialist taxonomic work on material of particular interest.

The core team of investigators in 1993-1994 consisted of J. Carlton (shelled gastropods, bivalves, barnacles, isopods, decapod crustaceans), J. Chapman (isopods,

amphipods, other percarids), A. Cohen (decapod crustaceans, bryozoa) and C. Mills (hydrozoa, scyphozoa), joined in 1996 by L. Harris (polychaetes), and assisted in the field by T. Gosliner (opisthobranchs), M. Kellogg (shelled gastropods), D. Sloan (foraminifers), L. Solarzano (algae), R. van Syoc (barnacles) and S. Cohen (tunicates). The same core team and assistants are expected to be available for work in 1997-98, with the addition of two interns (A. Weinstein and J. Crooks) to assist with benthic sampling, sorting, managing and curating material, and data entry. Additional field assistance will be provided in 1997-98 by W. Lee (sponges), R. Moe (algae), P. Silva (algae) and K. Wasson (entoprocts). As in 1996, taxonomic workup will be conducted at the Oceanside Water Quality Laboratory of the City and County of San Francisco.

Location/Geographic Boundaries

Core stations in 1993-1997 included stations from Bethel Island in the Delta to Coyote Hills in the South Bay, with supplemental stations in each segment of the Estuary. Additional core stations in the Delta will be added in 1997-98.

Expected Benefits

This project will include assessment of the effects of annual variations in water flows, including extreme wet flows, on biotic communities, including the priority habitat of tidal perennial aquatic habitat. Effects assessed will include relative impacts on exotic and native species. Contributions to a better understanding of how the stressor of exotic species responds to disturbance and to variation in flows could improve strategies for controlling existing invasions or preventing future invasions, which would likely benefit all priority habitats and species.

Investigation of the relationship between flows—in particular large seasonal flood flows—and the fouling and benthic communities will contribute to our understanding of: (1) how disturbance may be related to the initial success of an introduction; (2) shifts in species guilds that may affect trophic dynamics in the Estuary, with possible effect on desirable species or species of concern; and (3) shifts in the balance between native and nonindigenous species in the Estuary. Understanding these issues would be of broad ecosystem restoration and management interest.

Background and Biological/Technical Justification

The San Francisco Bay Estuary is recognized as the most invaded aquatic ecosystem in North America, with more than 200 introduced invertebrates, fish, plants, and microorganisms, and such introductions have in many cases had substantial effect on native species and habitats through predation, competition, habitat disturbance and alteration, changes in trophic dynamics, and other mechanisms. Introductions have been increasing in recent decades, and are likely to increase further with the current rapid expansion that is occurring in international trade and travel. The massive invasion of the Estuary by the Asian clam, *Potamocorbula amurensis*, with

the consequent immense capability of the this clam population to filter phytoplankton from the water column, has underscored the potential for exotic organisms to alter trophic dynamics and other fundamental ecosystem processes in the Estuary. Studies of the heavily invaded dock fouling community and shallow water benthos can contribute through Rapid Assessment methods can help elucidate variation in environmental parameters can contribute to the initial success of invasions, and can alter the ecosystem effects of invasions.

Current Status of Project

The current proposal is a new project, but would build upon several years of work in developing rapid assessment methods, and in building a team with the necessary expertise, for studying the fouling community, and take advantage of a baseline data set developed for this community from 1993-1996.

Interaction with Other Projects

This project will compare results from analyzing RA sampling of shallow water benthic stations with analysis of data from the IEP and RMP benthic sampling programs. This will augment the picture of the Estuary provided by the IEP/RMP data by extending sampling to a set of shallow station which differ in some ways from the IEP and RMP stations, and clarify to what extent results from one set of stations and sampling methodologies may be representative of results from the other.

Proposed Scope of Work

The work described under "Project Description and Approach" will be conducted over a three-year period. This work consists of sampling, taxonomic workup and analysis of fouling and benthic habitats in the Estuary.

An annual progress report will be provided to CALFED at the end of each of the first two years, and a Final Report at the end of the third year.

Monitoring and Data Evaluation

The draft report will be submitted to the contract manager and to regional biologists with appropriate expertise for external review and comment. In addition, any persons recommended by CALFED will be asked to review the report. Articles based on the results of this study will also be prepared for submission to peer-reviewed journals.

Implementability

There are no anticipated implementation issues. The principal investigator will hold a scientific collecting permit (issued by the State of California) for the duration of the project. No other permits are required for this project.

Budget Explanation

Calculated here for FY 98; increase rates by 5%/year for future years.

Travel**1. To/from Bay Area**

Carlton-2 trips fr Mystic CT@ [\$450 (plane) + \$50 (ground)]	1000.00
Chapman-2 trips fr Newport OR@ [\$150 (plane) + \$50 (ground)]	400.00
Crooks-2 trips fr San Diego CA@ [\$150 (plane) + \$50 (ground)]	400.00
Harris-2 trips fr Los Angeles CA@ [\$150 (plane) + \$50 (ground)]	400.00
Mills-2 trips fr Friday Harbor WA@ [\$250 (plane) + \$50 (ground)]	600.00
<u>Ruiz-2 trips fr Washington DC@ [\$450 (plane) + \$50 (ground)]</u>	<u>1000.00</u>
TOTAL	\$3800.00

2. Field work (within Bay Area)

Van rental-1 weeks@ \$500/week	500.00
Fuel (van)-1 weeks@ 500 mi/wk + 20 mpg x \$1.50/gal	37.50
<u>Mileage (private vehicle)-4 weeks @ 500 mi/wk x \$0.30/mi</u>	<u>1200.00</u>
TOTAL	\$1735.50

3. Per diems

6 people x 5 days @\$38/day	\$1140.00
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Travel-Total**\$6675.50****Taxonomy: consulting fees and shipping (e. g.)**

10 tasks x 2 days/task @ \$250/day	\$5000.00
10 shipments x \$25/shipment	\$250.00

Budget subtotals are provided for the project with and without the benthic sampling, as the fouling community study could be conducted as a stand-alone study. However, the benthic component provides an important analytical link to existing long-term benthic monitoring programs (IEP and RMP) at modest additional cost.

Cost Sharing

In-kind contributions calculated here for FY 98; estimated increase of 5%/year for future years.

Lodging (contributed by participants)

6 persons x 5 nights x \$100/night = \$3000

Laboratory use (contributed by the Oceanside Water Quality Laboratory of the City and County of San Francisco)

3 days x \$200/day = \$600

Field work (contributed by taxonomic assistants)
estimated 21 days x \$500/day = \$10500

Identification and curation of algae (contributed by Jepson Herbarium)
5 days x \$500/day = \$2500

total cost sharing

FY 1998	\$16600
FY 1999	\$17430
<u>FY 2000</u>	<u>\$18302</u>
Total	\$52332

Schedule

This is a three year project. Annual reports will be delivered at 12 and 24 months after the project start date. A Final Report will be delivered at 36 months after the project start date.

Project Tasks — FY1998	Direct Hours	Salary & Benefits	Overhead	Service Contracts	Other Direct Costs	Total Cost
Organization for Field Work						
Andrew Cohen	40	2334	1214			
Anna Weinstein	60	1004	522			
supplies					200	5273
Field Work						
Andrew Cohen	120	7002	3641			
John Chapman (1)	40		645	1519		
James Carlton (2)	40		140	1400		
Claudia Mills (2)	40		140	1400		
Leslie Harris (2)	40		140	1400		
Jeffrey Crooks	40	669	348			
Anna Weinstein	120	2008	1044			
travel					6676	
miscellaneous supplies					500	28672
Taxonomy (by team members)						
Andrew Cohen	160	9336	4855			
John Chapman (1)	320		5422	12758		
Leslie Harris (2)	120		420	4200		
miscellaneous supplies					200	37191
Taxonomy (by outside consultants)						
Andrew Cohen	40	2334	1214			
Anna Weinstein	80	1338	696			
consulting fees					5000	
shipping					250	10832
Data Entry						
Andrew Cohen	40	2334	1214			
Anna Weinstein	80	1338	696			5582

Project Tasks — FY1998 Continued	Direct Hours	Salary & Benefits	Overhead	Service Contracts	Other Direct Costs	Total Cost
Benthos-Field Work						
mini-Ponar grab, 6" x 6"					850	
miscellaneous supplies					200	1050
Benthos-Taxonomy (team members)						
John Chapman (1)	80		1291	3038		
Leslie Harris (2)	80		280	2800		
miscellaneous supplies					100	7509
Benthos-Taxonomy (consultants)						
Andrew Cohen	20	1167	607			
Anna Weinstein	40	669	348			
consulting fees					2500	
shipping					125	5416
Benthos-Data Entry						
Andrew Cohen	20	1167	607			
Anna Weinstein	40	669	348			2791
SUBTOTAL-WITHOUT BENTHOS		29697	22350		12826	87551
SUBTOTAL-BENTHOS		3672	3481		3775	16766
TOTAL-WITH BENTHOS		33370	25831		16601	104316

Project Tasks — FY1999	Direct Hours	Salary & Benefits	Overhead	Service Contracts	Other Direct Costs	Total Cost
Organization for Field Work						
Andrew Cohen	20	1225	637			
Anna Weinstein	40	703	365			
supplies					105	3036
Field Work						
Andrew Cohen	120	7352	3823			
John Chapman (1)	40		678	1595		
James Carlton (2)	40		147	1470		
Claudia Mills (2)	40		147	1470		
Leslie Harris (2)	40		147	1470		
Jeffrey Crooks	40	703	365			
Anna Weinstein	120	2108	1096			
travel					7009	
miscellaneous supplies					525	30107
Taxonomy (by team members)						
Andrew Cohen	160	9803	5098			
John Chapman (1)	320		5422	12758		
Leslie Harris (2)	120		441	4410		
miscellaneous supplies					210	38143
Taxonomy (by outside consultants)						
Andrew Cohen	40	2451	1274			
Anna Weinstein	80	1406	731			
consulting fees					5250	
shipping					263	11374
Data Entry						
Andrew Cohen	40	2451	1274			
Anna Weinstein	80	1406	731			5862

Project Tasks — FY1999 Continued	Direct Hours	Salary & Benefits	Overhead	Service Contracts	Other Direct Costs	Total Cost
Benthos-Field Work miscellaneous supplies					105	105
Benthos-Taxonomy (team members)						
John Chapman (1)	80		1356	3190		
Leslie Harris (2)	80		294	2940		
miscellaneous supplies					105	7884
Benthos-Taxonomy (consultants)						
Andrew Cohen	20	1225	637			
Anna Weinstein	40	703	365			
consulting fees					2625	
shipping					131	5687
Benthos-Data Entry						
Andrew Cohen	20	1225	637			
Anna Weinstein	40	703	365			2931
SUBTOTAL-WITHOUT BENTHOS		29608	22378		13362	88521
SUBTOTAL-BENTHOS		3856	3655		2966	16607
TOTAL-WITH BENTHOS		33464	26033		16328	105128

Project Tasks — FY 2000	Direct Hours	Salary & Benefits	Overhead	Service Contracts	Other Direct Costs	Total Cost
Organization for Field Work						
Andrew Cohen	20	1287	669			
Anna Weinstein	40	738	384			
supplies					110	3188
Field Work						
Andrew Cohen	80	5146	2676			
John Chapman (1)	40		712	1674		
James Carlton (2)	40		154	1544		
Claudia Mills (2)	40		154	1544		
Leslie Harris (2)	40		154	1544		
Jeffrey Crooks	40	738	384			
Anna Weinstein	80	1476	768			
travel					7360	
miscellaneous supplies					551	26579
Taxonomy (by team members)						
Andrew Cohen	120	7720	4014			
John Chapman (1)	280		4981	11721		
Leslie Harris (2)	120		463	4631		
miscellaneous supplies					221	33750
Taxonomy (by outside consultants)						
Andrew Cohen	20	1287	669			
Anna Weinstein	40	738	384			
consulting fees					2756	
shipping					138	5971
Data Entry						
Andrew Cohen	30	1930	1004			
Anna Weinstein	60	1107	576			4616
Analysis and Writing						
Andrew Cohen	240	15439	8028			
John Chapman (1)	240		4270	10046		
software					500	
software consulting					500	38784

Project Tasks — FY 2000 Continued	Direct Hours	Salary & Benefits	Overhead	Service Contracts	Other Direct Costs	Total Cost
Benthos-Field Work miscellaneous supplies					110	110
Benthos-Taxonomy (team members)						
John Chapman (1)	80		1423	3349		
Leslie Harris (2)	80		309	3087		
miscellaneous supplies					110	8278
Benthos-Taxonomy (consultants)						
Andrew Cohen	10	643	335			
Anna Weinstein	20	369	192			
consulting fees					1378	
shipping					69	2986
Benthos-Data Entry						
Andrew Cohen	20	1287	669			
Anna Weinstein	40	738	384			3077
Benthos-Analysis and Writing						
Andrew Cohen	40	2573	1338			
John Chapman (1)	160		2846	6698		13455
SUBTOTAL-WITHOUT BENTHOS		37605	30444		12136	112888
SUBTOTAL-BENTHOS		5610	7496		1668	27907
TOTAL-WITH BENTHOS		43215	37939		13803	140795

(1) Salary, benefits and overhead for John Chapman paid as a subgrant to Oregon State University.

(2) Paid as consultant.

San Francisco Estuary Institute

The San Francisco Estuary Institute (SFEI) is a 501(c)(3) non-profit created in 1994. SFEI is charged with fostering scientific understanding of the Estuary. SFEI's Biological Invasions Program researches issues of scientific and policy interest related to the introduction of nonindigenous species into marine and freshwater ecosystems.

Principal Participants

Principal participants are all part of the core sampling team that developed Rapid Assessment sampling methods for the fouling community in the San Francisco Estuary. They bring unique experience, skills and taxonomic knowledge to this project.

James T. Carlton
Williams College

Dr. Carlton is the Director of the Maritime Studies Program at Williams College-Mystic Seaport. He has studied the nonindigenous species in San Francisco Bay for over 30 years, and has published extensively on marine biological invasions. He is co-editor of the Third Edition of *Light's Manual, the Key to the Intertidal Invertebrates of the Central California Coast*, and is currently at work on the Fourth Edition. Recent national and international positions include: Co-Chair, Committee on Biological Diversity in Marine Systems, National Academy of Sciences/National Research Council (1993-1995); Chair, Working Group on Introductions and Transfers of Marine Organisms, International Council for the Exploration of the Sea (ICES) (1991-); Committee on Ships' Ballast Operations, Marine Board, National Academy of Sciences/National Research Council (1994-1996); U. S. Delegation to the Marine Environmental Protection Committee (MEPC) of the United Nations International Maritime Organization (1995-); Pacific Science Council, National Academy of Sciences/National Research Council (1997-). Honors received include: Fellow, AAAS (1994); Distinguished Research Fellow, U. C. Bodega Marine Laboratory (fall 1996); and Pew Fellow in Environment and Conservation (1996-99).

John Chapman
Oregon State University, Hatfield Marine Science Center

Dr. John Chapman received his Ph.D. from the University of California at Santa Barbara. He is the author of several papers on nonindigenous estuarine species in San Francisco Bay Estuary and the northeast Pacific and the criteria for introduced aquatic invertebrates. He was a participant and contributor 1995 USFWS report on

nonindigenous species in the San Francisco Estuary. Dr. Chapman is Co-Principal Investigator on two grants on the ballast water introductions of nonindigenous species in Valdez Alaska. He is presently completing research on potential global climate effects on nonindigenous species in northeast Pacific estuaries and a reevaluation of critical tide effects on marine organisms.

Andrew N. Cohen
San Francisco Estuary Institute

Dr. Cohen received an M. S. and Ph. D. in Energy and Resources from the University of California at Berkeley. He is the author of a 1995 USFWS report on nonindigenous species in the San Francisco Estuary and of papers on other aspects of marine and aquatic invasions. Dr. Cohen has also worked on and written about water system planning and economics, public health and contaminants in fish, and environmental mitigation; and has written articles and books for the general public on water and environmental policy and history. His work on invasions in the Estuary was profiled last year in the *New York Times* Science Page, and he was recently nominated to co-chair the Western Regional Panel on Aquatic Nuisance Species. He currently directs the San Francisco Estuary Institute's research program on biological invasions.

Leslie H. Harris
Los Angeles County Museum of Natural History

Ms. Harris has been working with polychaetes for the last 23 years. She is currently the polychaete collections manager of the Los Angeles County Museum of Natural History, one of the world's largest marine worm collections. She formerly held positions with the Southern California Coastal Water Research Project, MBC Applied Environmental Sciences, and Kinnetic Laboratories, and was Assistant Curator at the Allan Hancock Foundation, University of Southern California. She has done taxonomic consulting for the University of Alaska, California Academy of Sciences, Moss Landing Marine Laboratories, U. S. Navy, U. S. EPA, City of San Francisco, Monterey Bay Aquarium Research Institute, and Scripps Institute of Oceanography. Her current research interests include an investigation of the validity of polychaete species identified as non-native or introduced to the eastern Pacific, involving the comparison of eastern Pacific specimens with type and topotype material from around the world.

Claudia E. Mills
University of Washington Friday Harbor Laboratories

Dr. Mills has been working on marine invertebrates for about 25 years, with a specialization in Cnidaria and Ctenophora. She is author of the keys for

identification of Hydroids, Hydromedusae, Siphonophores, Scyphomedusae, Stauromedusae and Ctenophores in *Marine Invertebrates of the Pacific Northwest* (1987, 1996). She is currently revising these keys for the next edition of Light's Manual for California species. Dr. Mills has participated in the first three San Francisco Bay surveys (1993, 1994, 1996), from which she has published a paper in *Marine Biology* (1995) on two alien hydrozoan medusae found in tributaries to San Francisco Bay, and presented the survey team's preliminary hydroid data at the 1995 international meeting of the Society for Conservation Biology. She is completing a guidebook to the gelatinous zooplankton of the Pacific coast (co-authored with David Wrobel).

Intern Participants

Jeff Crooks
Scripps Institution of Oceanography

University (1987), and a M.S. in Ecology from San Diego State University (1992). Currently, he is a Ph.D. candidate at the Scripps Institution of Oceanography. His research has examined various aspects related to the invasion of non-indigenous species into the bay and estuarine ecosystems of Southern California. General areas of interest include the effects of habitat modification by exotic species, and the dynamics operating during the early stages of invasion. Other research topics have included describing the population ecology of an exotic mussel in Mission Bay, San Diego, and examining interactions of this invasive mussel with native invertebrates and shorebirds.

Anna Weinstein
San Francisco Estuary Institute

Anna Weinstein received an M.S. in marine science from the Boston University Marine Program in Woods Hole, MA. She has for the past 8 years worked in conservation biology, environmental policy analysis, and proposal writing for a variety of public and private groups in the San Francisco and Monterey Bay areas. She led procedural review and formal comment for these groups on a variety of environmental issues, designed field surveys for ecological assessments, and published numerous lay articles on topics in biology and policy. She was the principal grants writer for the Watershed Ecology Group of California State University Monterey Bay, raising over \$400,000. She currently works on exotic species ecology and management at the San Francisco Estuary Institute, and on program development and grant proposal writing for the Island Conservation and Ecology Group at U. C. Santa Cruz.

NONDISCRIMINATION COMPLIANCE STATEMENT

COMPANY NAME

SAN FRANCISCO ESTUARY INSTITUTE

The company named above (hereinafter referred to as "prospective contractor") hereby certifies, unless specifically exempted, compliance with Government Code Section 12990 (a-f) and California Code of Regulations, Title 2, Division 4, Chapter 5 in matters relating to reporting requirements and the development, implementation and maintenance of a Nondiscrimination Program. Prospective contractor agrees not to unlawfully discriminate, harass or allow harassment against any employee or applicant for employment because of sex, race, color, ancestry, religious creed, national origin, disability (including HIV and AIDS), medical condition (cancer), age, marital status, denial of family and medical care leave and denial of pregnancy disability leave.

CERTIFICATION

I, the official named below, hereby swear that I am duly authorized to legally bind the prospective contractor to the above described certification. I am fully aware that this certification, executed on the date and in the county below, is made under penalty of perjury under the laws of the State of California.

OFFICIAL'S NAME

Margaret R. Johnston

DATE EXECUTED

July 25, 1997

EXECUTED IN THE COUNTY OF

Contra Costa County

PROSPECTIVE CONTRACTOR'S SIGNATURE

PROSPECTIVE CONTRACTOR'S TITLE

Executive Director

PROSPECTIVE CONTRACTOR'S LEGAL BUSINESS NAME

San Francisco Estuary Institute